

Acoustic Band Gaps in Sonic Crystal Composites for Audible Frequency Noise Reduction: N.K. Batra and P. Matic, Code 6350, Naval Research Laboratory, Washington DC, USA.

Audible noise from machinery and other sources can be not only annoying but also a health hazard to personnel nearby. This noise is generally band limited in a certain frequency range and should be abated. Commercially available sound absorbing materials attenuate sound over a broad frequency band; but the attenuation may not sufficient in the desired frequency band. We are fabricating and characterizing geometrically compact composites called sonic crystals for shielding against noise generally limited to a particular frequency band. These composites have periodic arrays of macroscopic acoustic scatterers arranged in a 2-D or 3-D pattern analogous to a single crystal lattice in a host matrix material. The solid scatterers of relatively high acoustic impedance are imbedded in a host matrix material of low acoustic impedance or *vice versa*. We have fabricated several specimens of sonic crystals using, e.g., solid metal spheres, hollow metal beads, rods or tubes arranged in a lattice pattern and embedded in an unsaturated polyester resin matrix. We have demonstrated that in these composites, the sound transmission coefficient for certain frequencies drops abruptly, giving rise to frequency band gaps.

In order to measure acoustic band gaps in these acoustic-damping materials, an audio loudspeaker directs sound consisting of white noise at the sonic crystal specimen placed in a reflectionless acoustic enclosure. The transmitted sound amplitude is measured by a wide band microphone; fast Fourier transformed and normalized to obtain transmission coefficient spectra. Data was obtained, for many sonic crystal specimens and analyzed. For example, for a sonic crystal made of 0.125-inch diameter metallic beads in a simple cubic lattice (13x13x13 array, with spacing of 0.16 inch between the beads) and cast in an unsaturated polyester resin matrix, we measured a band gap of ~ 3800 Hz located at ~ 3540 Hz where the drop in the transmission coefficient was ~ 11.5 dB. The reduction in transmission coefficient in the band gaps depends upon the material properties of scatterers and host, fill ratio and lattice configuration. We will present detailed results for acoustic band gaps in the propagation of sound waves through several macroscopic sonic crystal composites with various types of scatterers arranged in 2-D and 3-D and explore their industrial uses for noise reduction.

*Acknowledgement: The authors wish to thank Dr. Leo Christodoulou, DARPA DSO, for his support for this work.*